

§31. Analyses of Generation and Behavior of Fine Particles by Laser Light Scattering

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The generation and transport of dusts in a nuclear fusion reactor is one of the serious issues that should be solved. To reduce the generation and transport to out of a reactor, the *in-situ* analysis of dust behavior will bring a lot of information about it. We are developing a *in-situ* analytical method of laser light scattering in Large Helical Device (LHD). The method applies Mie-scattering ellipsometry, which determines the change of polarization state of laser light by scattering from dusts.^{1,2)} The change of polarization state, which are expressed by the arctangent of absolute value of ratio of two amplitude functions, Ψ , and the phase angle of the ratio, Δ , has correlation with the complex refractive index, m , and size, d , of dusts as well as scattering angle, ϕ . In this year, we designed and constructed the system of Mie scattering ellipsometry and examined the feasibility of the *in-situ* analysis.

For the *in-situ* measurement in LHD, polarized laser light is projected into a diverter through a view port. The polarization state of scattered light is detected at a scattering angle or some of scattering angles. To analyze the size, size distribution, optical property, and density of dusts, growing process monitoring or multi scattering-angle measurement is a possible method. Better conditions for the two analytical method was examined by simulation. Simulation was carried out for a spherical graphite sphere, of which the refractive index at the wavelength of 532 nm is $2.66-j1.33$.³⁾

Figure 1 shows the results of calculation of Ψ and Δ for spherical diameter from 10 nm to 1000 nm every 10 nm at three scattering angles, $\phi = 45^\circ, 90^\circ, 135^\circ$. The directions of increase of diameter are indicated by arrows in the figures. By the comparison among the three Ψ - Δ trajectories, it is found that the analysis of dust growth is adequate at $\phi = 90^\circ$ in growing process monitoring.

Figure 2 shows the results of calculation of Ψ and Δ at the diameter of 500 and 1000 nm for scattering angle of $\phi = 30$ to 150° . For the analysis of diameter of dusts by multi scattering-angle measurement, it is found that analyzers are appropriate to be set at angles of forward scattering to 90° .

Because it is difficult to observe scattered light from the outside of a diverter at scattering angles above-mentioned, analyzers should be installed in the inside. The adequate scattering angle of detection is 90° in the analysis of growing process monitoring, while adequate angles distribute in forward direction to 90° in the analysis of multi scattering-angle measurement.

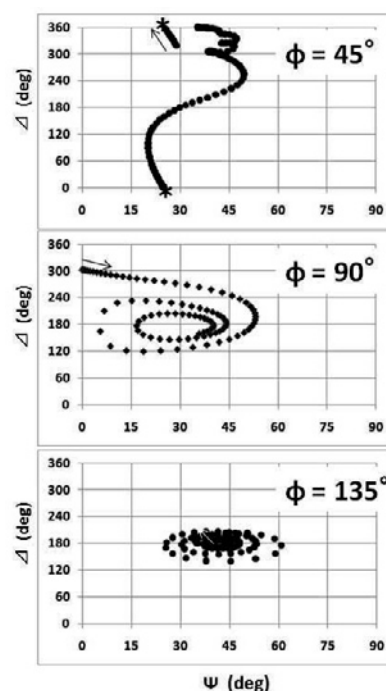


Fig. 1. Calculated results of Ψ and Δ for every 10 nm of diameter of sphere to 1000 nm at three scattering angles, $\phi = 45^\circ, 90^\circ, 135^\circ$.

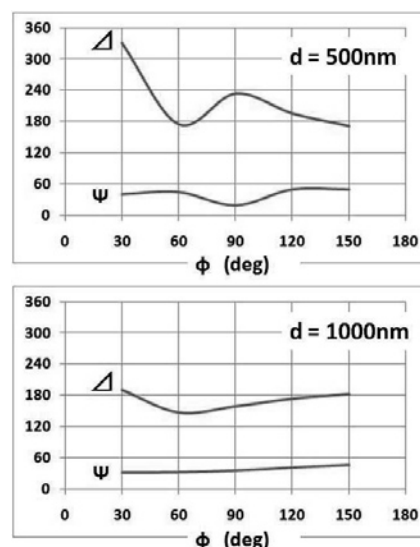


Fig. 2. Calculated results of Ψ and Δ at the diameter of 500 and 1000 nm for scattering angle $\phi = 30$ to 150° .

1) Yasuaki Hayashi and Kunihide Tachibana: Jpn. J. Appl. Phys. **33** (1994) L476.

2) Yasuaki Hayashi and Kunihide Tachibana: Jpn. J. Appl. Phys. **33** (1994) 4208.

3) A. Borghesi and G. Guizzetti: *Handbook of Optical Constants of Solid II* (ed. Edward D. Palik, ACADEMIC PRESS INC., 1991), p.458.